CLAIMS

What is claimed is:

1. A method for making a metallization structure for a semiconductor device, comprising:

forming a substantially planar first dielectric layer on a substrate;

forming at least one metal layer over the first dielectric layer;

forming a conducting layer over the metal layer;

forming a second dielectric layer over the conducting layer;

removing aligned portions of the second dielectric layer, conducting layer, and metal layer to form a multi-layer structure; and

forming metal spacers on sidewalls of the multi-layer structure.

2. The method of claim 1, wherein forming the first dielectric layer comprises forming a silicon oxide or BPSG layer.

3. The method of claim 2, further including forming the at least one metal layer of Ti, Ta, W, Co or Mo or an alloy or a compound of any thereof, including TaN or TiN.

4. The method of claim 3, further including forming a second metal layer between the first metal layer and the substrate and comprising TiN, TiW, WN, or TaN.

5. The method of claim 1, further including forming the at least one metal layer of titanium or titanium nitride.

6. The method of claim 1, wherein the at least one metal layer is a single metal layer and further comprising forming the single metal layer of titanium or titanium nitride.

7. The method of claim 1, further comprising forming the conducting layer from the group comprising aluminum and copper.

8. The method of claim 7, further including forming the conducting layer of an aluminum-copper alloy.

9. The method of claim 1, further including forming the metal spacers of at least one layer of Ti, Ta, W, Co or Mo, or alloys thereof or compounds thereof, including TaN and TiN.

10. The method of claim 9, further including forming the metal spacers of titanium or titanium nitride.

11. The method of claim 1, further comprising forming a dielectric layer on the conducting layer to have sidewalls aligned with the conductive layer sidewalls, and forming the metal spacers to extend along the sidewalls of the dielectric layer.

12. The method of claim 11, further comprising forming the dielectric layer of a low dielectric constant material.

13. The method of claim 12, further comprising forming the dielectric layer of a fluorine-doped silicon oxide.

14. The method of claim 1, further comprising forming the at least one metal layer and the metal spacers of the same metal.

15. The method of claim 1, further comprising forming the at least one metal layer by vapor deposition.

16. The method of claim 14, further comprising forming the at least one metal layer by CVD, PVD or PECVD.

17. The method of claim 1, further comprising forming the conducting layer by vapor deposition.

18. The method of claim 17, further comprising forming the conducting layer by CVD, PVD or PECVD.

19. The method of claim 1, further comprising forming the metal spacers by vapor deposition and directional etching.

20. The method of claim 19, further comprising effecting the vapor deposition as CVD, PVD or PECVD.

21. The method of claim 1, wherein removing aligned portions of the second dielectric layer, conducting layer, and metal layer to form a multi-layer structure is effected by patterning and etching the second dielectric layer, the conducting layer, and the metal layer.

22. The method of claim 1, further comprising forming the metal spacers by forming a metal spacer layer over the multi-layer structure and first dielectric layer and removing portions thereof overlying the first and second dielectric layers.

23. The method of claim 22, further comprising forming the metal spacer layer over the multi-layer structure and first dielectric layer by a conformal deposition process.

24. The method of claim 23, wherein the portions of the metal layer over the multi-layer structure and first dielectric layer are removed by etching.

25. The method of claim 1, further comprising:

removing any remaining portion of the second dielectric layer and upper portions of the metal spacers laterally adjacent thereto.

26. The method of claim 25, further comprising removing any remaining portion of the second dielectric layer and upper portions of the metal spaces by etching.

27. A method for making a metallization structure comprising:

forming a substrate comprising at least one metal layer on the surface thereof;

forming a dielectric layer over at least one the metal layer;

forming an aperture having at least one sidewall through the dielectric layer to expose a surface of the at least one metal layer;

forming a metal spacer on the at least one sidewall of the aperture; and

forming a conductive layer in a remaining portion of the aperture.

28. The method of claim 27, further comprising forming the dielectric layer of silicon oxide.

29. The method of claim 27, further including forming the at least one metal layer of Ti, Ta, W, Co or Mo or alloys or compounds thereof, including TaN or TiN.

30. The method of claim 29, wherein the at least one metal layer comprises a first metal layer, and further including forming a second metal layer between the first metal layer and the substrate and comprising TiN, TiW, WN, or TaN.

31. The method of claim 27, further including forming the at least one metal layer of titanium or titanium nitride.

32. The method of claim 27, further comprising forming the at least one metal layer by vapor deposition.

33. The method of claim 32, further comprising forming the at least one metal layer by CVD, PVD or PECVD.

34. The method of claim 27, further comprising forming the conducting layer by vapor deposition.

35. The method of claim 34, further comprising forming the conducting layer by CVD, PVD or PECVD.

36. The method of claim 27, further comprising forming the at least one metal layer and the metal spacer of the same metal.

37. The method of claim 27, further comprising forming the metal spacer by vapor deposition and directional etching.

38. The method of claim 27, further including forming the metal spacer of at least one layer of Ti, Ta, W, Co or Mo, or alloys or compounds thereof, including TaN or TiN.

39. The method of claim 38, further including forming the metal spacer of titanium or titanium nitride.

40. The method of claim 27, further comprising forming at least one upper metal layer on the conductive layer.

41. The method of claim 40, further comprising forming the at least one upper metal layer on the conductive layer from Ti, Ta, W, Co or Mo or alloys or compounds thereof, including TaN or TiN.

42. The method of claim 40, further comprising forming the at least one upper metal layer as a plurality of upper metal layers.

43. The method of claim 40, further comprising forming the at least one upper metal layer of titanium or titanium nitride.

44. The method of claim 40, further comprising forming the at least one upper metal layer by vapor deposition.

45. The method of claim 44, wherein the vapor deposition is effected by CVD, PVD or PECVD.

46. The method of claim 27, further comprising removing the dielectric layer and portions of the at least one metal layer not underlying the aperture.

47. The method of claim 46, further comprising removing the dielectric layer by using a hydrofluoric acid wet etch solution or an oxide dry etch process.

48. The method of claim 46, further comprising removing the portions of the at least one metal layer by directional etching.

49. A method for making a metallization structure comprising:

forming a substrate comprising at least one metal layer on the surface thereof;

forming a dielectric layer over the at least one metal layer;

forming an aperture through the dielectric layer to expose a surface of the at least one metal layer;

forming a conducting layer in the aperture;

forming at least one upper metal layer overlying the dielectric layer and the conducting layer in the aperture;

removing portions of the at least one upper metal layer overlying the dielectric layer, removing the dielectric layer, and removing portions of the at least one metal layer surrounding the conducting layer to form a multi-layer metal structure having at least one sidewall; and forming a metal spacer on the at least one sidewall of the multi-layer metal structure.

50. The method of claim 49, further comprising forming the dielectric layer of silicon oxide.

51. The method of claim 49, further including forming the at least one metal layer of Ti, Ta, W, Co or Mo or alloys or compounds thereof, including TaN or TiN.

52. The method of claim 51, wherein the at least one metal layer comprises a first metal layer, and further including forming a second metal layer between the first metal layer and the substrate and comprising TiN, TiW, WN, or TaN.

53. The method of claim 49, further including forming the at least one metal layer of titanium or titanium nitride.

54. The method of claim 49, further comprising forming the at least one metal layer by vapor deposition.

55. The method of claim 54, further comprising forming the at least one metal layer by CVD, PVD or PECVD.

56. The method of claim 49, further comprising forming the conducting layer by vapor deposition.

57. The method of claim 56, further comprising forming the conducting layer by CVD, PVD or PECVD.

58. The method of claim 49, further comprising forming the at least one metal layer and the metal spacer of the same metal.

59. The method of claim 49, further comprising forming the metal spacer by vapor deposition of a metal layer over the multi-layer metal structure and directional etching of the vapor-deposited metal layer.

60. The method of claim 49, further including forming the metal spacer of at least one layer of Ti, Ta, W, Co or Mo, or alloys thereof or compounds thereof, including TaN or TiN.

61. The method of claim 60, further including forming the metal spacer of titanium or titanium nitride.

62. The method of claim 49, further comprising forming the at least one upper metal layer on the conducting layer from Ti, Ta, W, Co or Mo or an alloy or a compound of any thereof, including TaN or TiN.

63. The method of claim 62, further comprising forming the at least one upper metal layer as a plurality of upper metal layers.

64. The method of claim 49, further comprising forming the at least one upper metal layer of titanium or titanium nitride.

65. The method of claim 49, further comprising forming the at least one upper metal layer by vapor deposition.

66. The method of claim 65, wherein the vapor deposition is effected by CVD, PVD or PECVD.

67. The method of claim 49, further comprising removing the dielectric layer by using a hydrofluoric acid wet etch solution or an oxide dry etch process.

68. The method of claim 49, further comprising removing the portions of the at least one metal layer by directional etching.

69. The method of claim 49, further comprising forming the conducting layer from at least one of aluminum and copper.

70. The method of claim 49, comprising forming the metal layer, metal spacer, and upper metal layer of the same metal.

71. The method of claim 70, wherein the metal is Ti.